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13. ABSTRACT *(Maximum 200 words)*

The object of this research was to characterize the effects of material age and environmental humidity on fatigue crack growth behavior of 2024-T3, 2024-T4, and 7075-T6 aluminum alloys. These alloys were taken from the fuselage and wing skin of USAF C/KC-135 aircraft representative of the USAF Fleet of C/KC-135 aircraft in age and mission use. The research was broken down into two activities: Experimental testing and data reduction comparison.

The test was designed to further the understanding of the effects of humidity on the aluminum alloy's fatigue crack growth rate. The testing performed involved identical test specimen configurations of "aged" material subjected to loading while exposed to two different levels of "wet" and "dry". These test results were compared to the results of similar test results involving relatively "new" materials to determine if there were any age effects. Of the three materials only Al7075-T6 demonstrated humidity effects, and Al2024-T3 demonstrated no age effects. The effect of age on fatigue crack growth rates of materials is minimal, while the effects attributed to corrosion appear much more severe.

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FOREWORD

This report was prepared by Analytical Services & Materials, Inc., Hampton Virginia for WL/FIBEC, Wright-Patterson Air Force Base, Ohio under contract F33615-94-D-3212, "Structural Integrity Analysis and Verification for Aircraft Structures." The contract monitor was Mr. James A. Harter, WL/FIBEC. The government project engineer responsible for this effort was Capt. Daniel J. Groner. The period of performance for this report was 4 May 95 through 31 Sept 95.

The work performed under this project (Delivery Order 0005) was performed by Analytical Services & Materials, Inc. personnel located at the WL/FIBEC Fatigue & Fracture Test Facility, Bldg. 65, Area B, Wright-Patterson AFB, OH. The Principal Investigator of this research was Mr. Kevin L. Boyd. The authors of this report were Mr. Daniel A. Jansen and Mr. Kevin L. Boyd. Technical inputs were submitted by Mr. James A. Harter and Capt. Daniel J. Groner.

1. INTRODUCTION

The C/KC-135 first entered service in 1957; as some of these aircraft approach 40 years of service, corrosion has become an important consideration in the aircraft structural health. Understanding the effects of age and humidity on the fatigue characteristics of the aircraft structure should improve the ability to monitor the aircraft structural health and reliability. This effort was part of the larger "Integrated C/KC-135 Corrosion Program Round Robin Test Program" sponsored by the Oklahoma City Air Logistics Center. The testing performed for this program was intended to characterize the fatigue crack growth behavior of aged 2024-T3, 2024-T4 and 7075-T6 Al alloys subjected to low (<15%) and high (>85%) levels of relative humidity. These materials were taken from retired C/KC-135 aircraft by government personnel and are believed to representative of the general fleet with respect to age and overall condition.

In order to quantify the degradation in material behavior due to the influence of age and humidity, it is very important that testing be performed under reduced variable conditions. By limiting variables to material age and environmental humidity, comparisons between data will better demonstrate the effect of those variables. For example, in two tests that differ only in the material's age, any variation in test results can be attributed to age with greater confidence. It is anticipated that the data generated under this research effort will aid in the understanding of age and humidity effects on the crack-growth behavior of 2024-T3, 2024-T4 and 7075-T6 Al alloys.

2. EXECUTIVE SUMMARY

The objective of this research was to characterize the effects of material age and environmental humidity on the fatigue-crack-growth behavior of 2024-T3, 2024-T4 and 7075-T6 Al alloys. These alloys were taken from the fuselage and wing skin of USAF C/KC-135 aircraft representative of the USAF fleet of C/KC-135 aircraft in age and mission use. The research was broken down into two activities: experimental testing and data reduction and comparison.

The experimental testing activity consisted of two tasks. The first task was to perform specimen testing under "wet" (>85% relative humidity) conditions while the second task was to perform testing under "dry" (<15% relative humidity) conditions. For each task, middle tension specimens of the three aluminum alloys had cracks grown from machined center notches to predetermined lengths before test data was recorded.

Test data was compared to data from the Damage Tolerant Design Handbook (WL-TR-94-4055) and WL/FIBEC in-house data to determine the effects of age and humidity. The in-house data was obtained, over time, from standard laboratory test specimens. This "standard" data was generally from pristine material that had been taken from sheet or plate stock. Standard tests were generated under ambient air, temperature, and humidity conditions.

Plots of da/dN vs. ΔK indicated that the fatigue crack growth rates of the 7075-T6 Al alloy were influenced by the presence of humidity while the fatigue crack growth rates of the 2024 Al alloys were not.

Additionally, age comparisons made for 2024-T3 aluminum suggested no age effects, whereas comparisons for 7075-T6 aluminum were inconclusive due to the lack of control data. Age comparisons were not made for 2024-T4 aluminum due to the lack of data for non-aged material.

3. TESTING

3.1. Specimen Configurations

The specimens used in this test program were prepared by Boeing-PSD Engineering and delivered in "as-received" condition [1]. "As-received" means that the material was obtained from the fuselage of retired C/KC-135 aircraft without artificial corrosion. The alloys were all clad, with nominal thickness of 0.063 inches, and TL specimen orientation. The test specimens were prepared as ASTM E647-93 Middle Tension specimens with EDM wire cut starter notches (Figure 1). The area local to the starter notch had been polished to facilitate optical crack measurement and protected with special cellophane tape which had no adhesive residue.

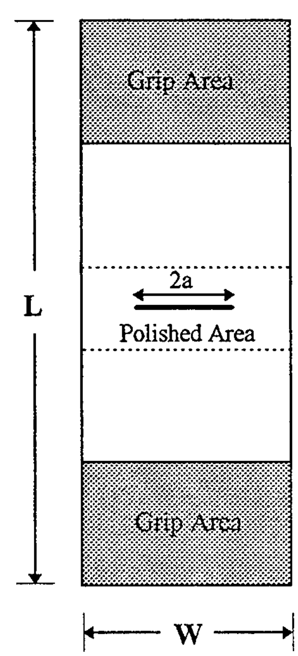

Figure 1 Typical Middle Tension Specimen According to ASTM E647-93

The nominal specimen dimensions are shown in the table below:

Table 1 Nominal Specimen Dimensions

Alloy	# of Specimens	Width	Length	Thickness	Starter Notch (2a)
2024-T3	8	1.75	7.0	0.063	0.350
2024-T4	8	1.50	6.0	0.063	0.300
7075-T6	8	1.75	7.0	0.063	0.350

3.2. Testing Apparatus

All testing was performed in the Fatigue & Fracture Test Facility, Building 65, Area B, Wright-Patterson AFB, Ohio. The specimens were tested in either a 35 kip or 20 kip MTS servo-hydraulic fatigue test frame using 5 kip and 2 kip load range settings respectively. These test frames are numbered 14 and 15 in the test facility. All tests were conducted at 10 Hz. These test frames were operated in load control using MTS Model 458 test controllers with load signals generated on MS-DOS based computers running MATE software. MATE, MAterial Test and Evaluation, is a software package written by the University of Dayton Research Institute. Load cell data from the MTS Model 458 was recorded using High Gain DC conditioners and a Model RS3800 strip chart recorder. Crack lengths were measured optically using Gaertner Scientific microscopes mounted on Velmex Unislide precision sliding assemblies with a graduated scale of precision ±0.0005 inches.

The two humidity conditions tested were artificially introduced using an ordinary aquarium air pump to pump air into a column of water (or desiccant), then into a small chamber surrounding the test specimen. The air pump was controlled by a humidity sensor mounted in-line with an exhaust hose leading away from the chamber. For the "wet" testing, the column was filled with ASTM D1193 Type III or better reagent water to provide high humidity air. During the "dry" testing, the water was replaced with DESI-PAK, a clay mineral desiccant from United Catalysts Inc. The desiccant conformed to standard Mil-D-3464E. These setups easily provided a relative humidity above 85% and below 15%, respectively.

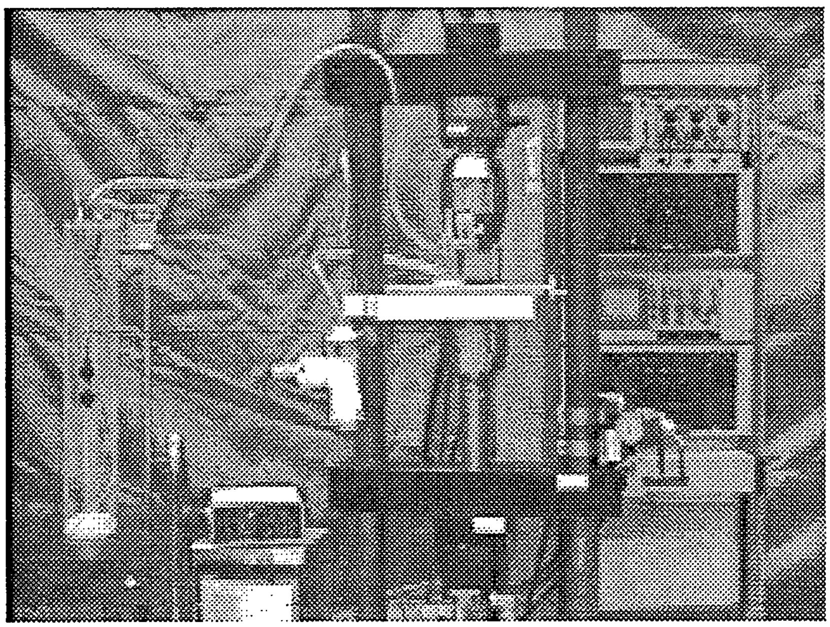

Figure 2 Typical Test Apparatus Showing Configuration for "Dry" Test

3.3. Testing Conditions

The test program consisted of three materials, two stress ratios ($R = \sigma_{min}/\sigma_{max}$), and two humidity ranges as shown in Table 2.

Table 2 Test Matrix for Humidity Effects

Alloy	# of Specimens	Stress Ratio	Humidity Level
2024-T3	2 each	0.05	>85%
			<15%
		0.50	>85%
			<15%
2024-T4	2 each	0.05	>85%
			<15%
		0.50	>85%
			<15%
7075-T6	2 each	0.05	>85%
			<15%
		0.50	>85%
			<15%

The specimens were subjected to the loads and conditions specified by the Integrated Round Robin Testing Program [1] and designated on each specimen traveling data sheet, as listed in Appendix A.

The crack for each specimen was grown an additional 0.100 inches from the starter notch during pre-cracking. The pre-cracking loads were identical to the test loads and were introduced under ambient humidity and temperature conditions. After pre-cracking, an environmental chamber was placed around the test specimen and environmental conditions were allowed to stabilize at the predetermined humidity levels before fatigue crack-growth rate testing began.

During testing, the specimens were subjected to constant amplitude fatigue loading with a frequency of 10 Hz at the designated maximum stress and stress ratio (R) . The specimens were fatigued sufficiently for the total crack (2a) to grow 0.030 inches, at which time the crack was measured. During crack measurement, the specimen was loaded to eighty percent of the test maximum stress to facilitate optical measurements.

The result of this testing was a record of crack length versus cycle count. The data was hand recorded on each specimen's traveling data sheet. These records can be found in Appendix B.

4. DATA REDUCTION

During testing, crack lengths were recorded at cyclic intervals sufficient to grow the total crack (2a) approximately 0.030 inches. These data were then transferred into an EXCEL spreadsheet where mathematical relationships were solved for stress intensities and crack-growth rates.

The secant method [2] was used to calculate fatigue crack-growth rates, where:

$$\frac{da}{dN} = \frac{((a_{r1} - a_{l1}) - (a_{r0} - a_{l0}))/2}{(N_1 - N_0)} \qquad \textbf{Equation 1}$$

where: a_{r1} = Current Right Crack Tip Measurement
a_{r0} = Previous Right Crack Tip Measurement
a_{l1} = Current Left Crack Tip Measurement
a_{l0} = Previous Left Crack Tip Measurement
N_1 = Current Cycle Count
N_0 = Previous Cycle Count

This equation (5-1) gives the average crack-growth rate for the cyclic interval between the two measurements.

To calculate the applied stress intensity range, ΔK, the following equations were used:

$$\Delta K = \frac{\Delta P}{B}\sqrt{\frac{\pi\alpha}{2W}\sec\left(\frac{\pi\alpha}{2}\right)} \qquad \textbf{Equation 2}$$

$$\alpha = \frac{2\left(\frac{(a_{r1} - a_{l1}) + (a_{r0} - a_{l0})}{4}\right)}{W} \qquad \textbf{Equation 3}$$

where: ΔP = Maximum Load - Minimum Load for stress ratios greater than 0
B = Thickness of the Specimen
W = Width of the Specimen

This form of the stress intensity factor equation was used in order to calculate the stress intensity for the average crack length of the cyclic interval. This corresponded to the crack length used in the secant method of calculating the fatigue crack-growth rate (Equation 1).

These data were then plotted for da/dN vs. ΔK on a log-log graph and can be found in Section 5.

5. DATA ANALYSIS

To determine the effect of humidity on fatigue crack-growth rates, plots of da/dN vs. ΔK were compared by humidity level for the same materials at the same stress ratios. The data from this test program were compared to data retrieved from the Damage Tolerant Design Handbook [3] and existing in-house data to determine if there were any age effects

5.1. 2024-T3 Aluminum Alloy

Figures 3 and 4 contain the fatigue crack-growth rate data for the 2024-T3 Al alloy. Each figure contains data for four specimens tested at the same stress ratio but two different humidity levels. Also, the figures contain in-house data from pristine material for age comparisons.

Figure 3 shows the "wet" and "dry" data for R=0.05 and suggests no apparent humidity effect on the fatigue crack-growth rates of the 2024-T3 Al alloy. Since these data closely resemble in-house data, it might be concluded that aged material has the same fatigue crack-growth rate characteristics as new material. Likewise, the data for the tests at R=0.50 (shown in Figure 4) suggest the same conclusions.

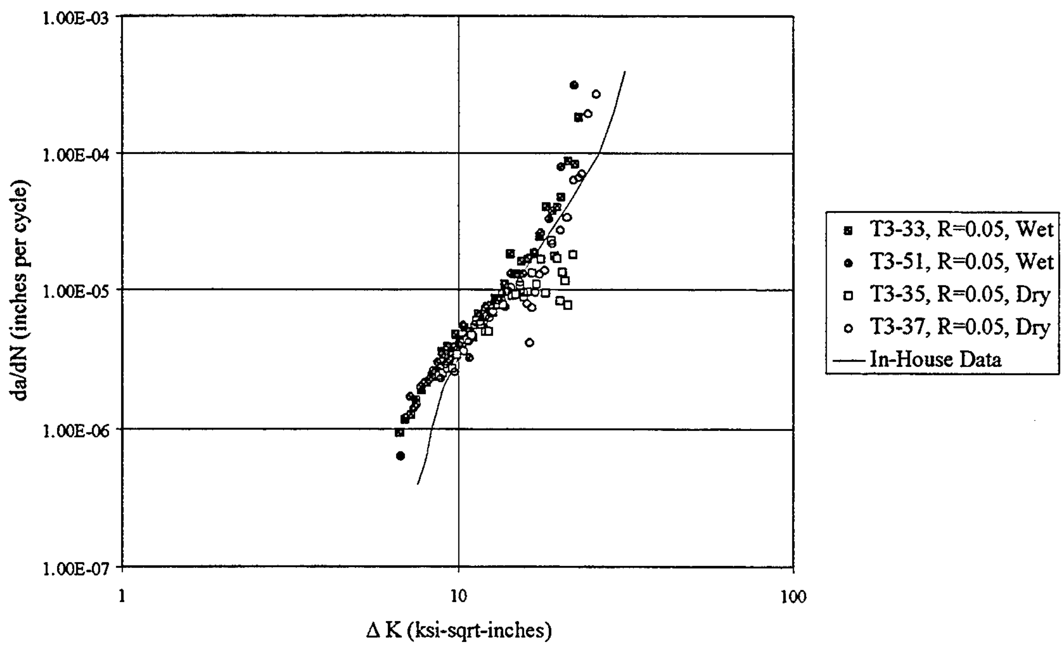

Figure 3 Fatigue Crack Growth Rates for 2024-T3 Al; R=0.05

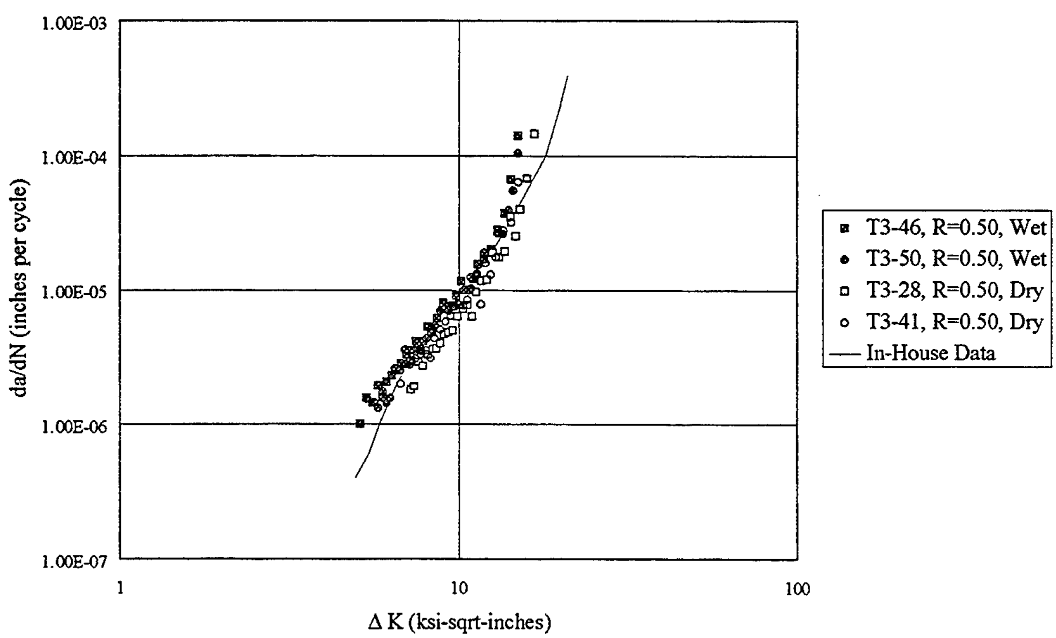

Figure 4 Fatigue Crack Growth Rates for 2024-T3 Al; R=0.50

5.2. 2024-T4 Aluminum Alloy

Figures 5 and 6 show the "wet" and "dry" crack-growth rate data for the 2024-T4 Al alloy. Each figure contains data for the same stress ratios but different humidity levels. There were no published fatigue-crack-growth-rate data available from the Damage Tolerant Design Handbook [3] or in-house to make comparisons between aged and new materials of this aluminum alloy. Therefore, there were no comparisons of this nature made in this report.

At both stress ratios, there was little or no variation of data due to humidity. While Figure 5 demonstrates some scatter of the data, the scatter is consistent within both humidity levels and does not necessarily indicate any appreciable differences in fatigue crack-growth rates. Figure 6 shows both "wet" and "dry" data at the higher stress ratio with less scatter and no apparent humidity effect.

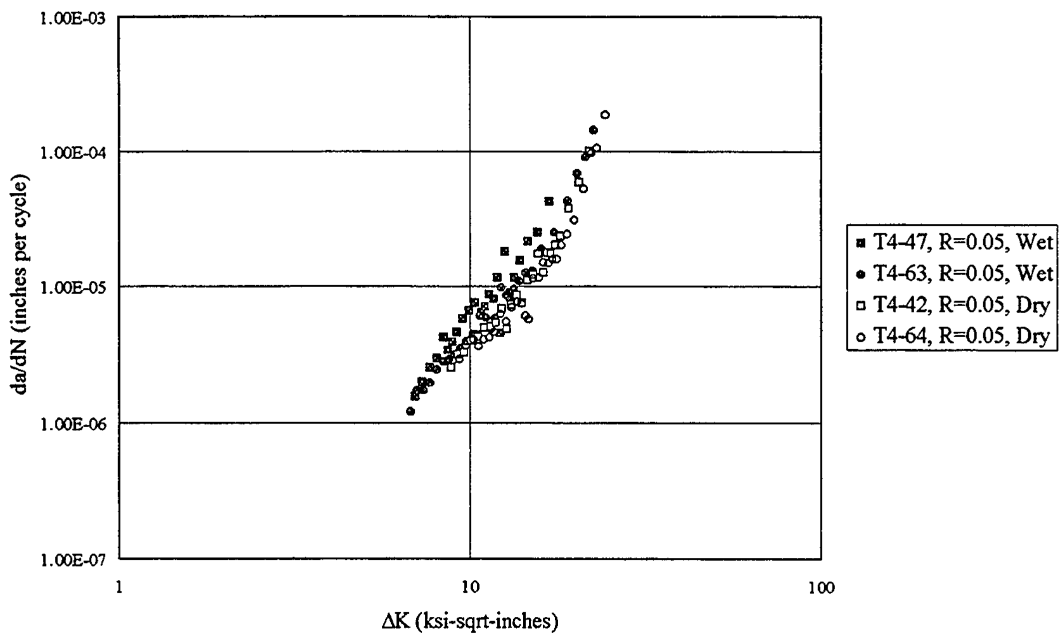

Figure 5 Fatigue Crack-Growth Rates for 2024-T4 Al; R= 0.05

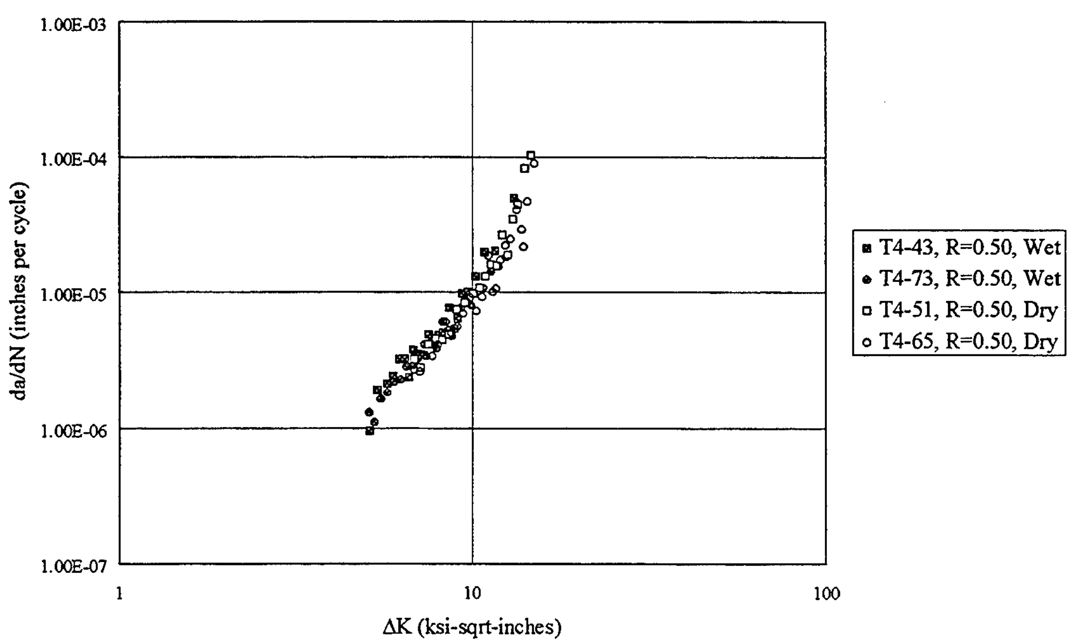

Figure 6 Fatigue Crack-Growth Rates for 2024-T4 Al; R= 0.50

5.3. 7075-T6 Aluminum Alloy

Figures 7 and 8 contain the fatigue crack-growth rate data for the 7075-T6 Al alloy. Figure 7 contains the limited data found in the Damage Tolerant Design Handbook [3] for 7075-T6 aluminum tested at a stress ratio of 0.50. It should be noted that both plots include in-house data for 7075-T651 aluminum. The 7075-T6 aluminum was not represented in the in-house data, and 7075-T651 aluminum was used because of its similarity in fatigue crack-growth rate behavior to the tested material. Both the handbook and in-house data correspond to non-aged material tested in room temperature lab air environments with "ambient" humidity levels of approximately 50-70% which could be used for age effect comparisons.

Both figures (7 and 8) show a clear difference in the fatigue crack-growth rates of 7075-T6 aluminum subjected to different humidity levels which could be attributed to the effect of humidity. Again in both figures, the "wet" test data agrees with the Design Handbook and the lower portion of the in-house data curve. This resemblance between data sets might be attributable to a lack of age effects or an interaction of the effects of age and humidity. The design of the test matrix and limited number of specimens did not allow for the isolation of possible age effects from humidity effects, so it is unclear what effect age had on the fatigue crack-growths rates of 7075-T6 aluminum.

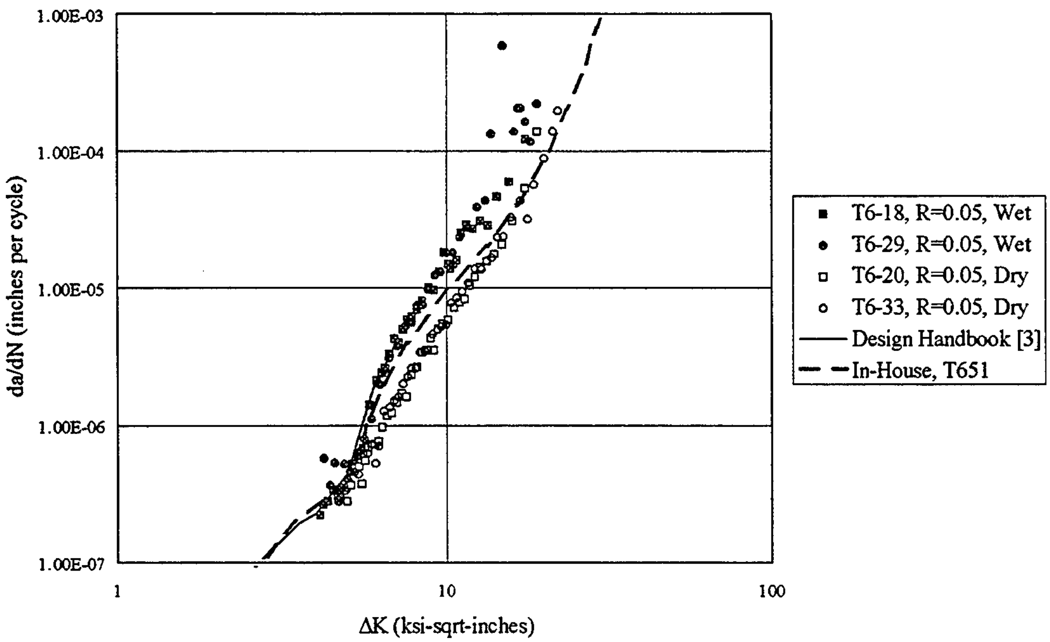

Figure 7 Fatigue Crack Growth Rates for 7075-T6 Al; R= 0.05

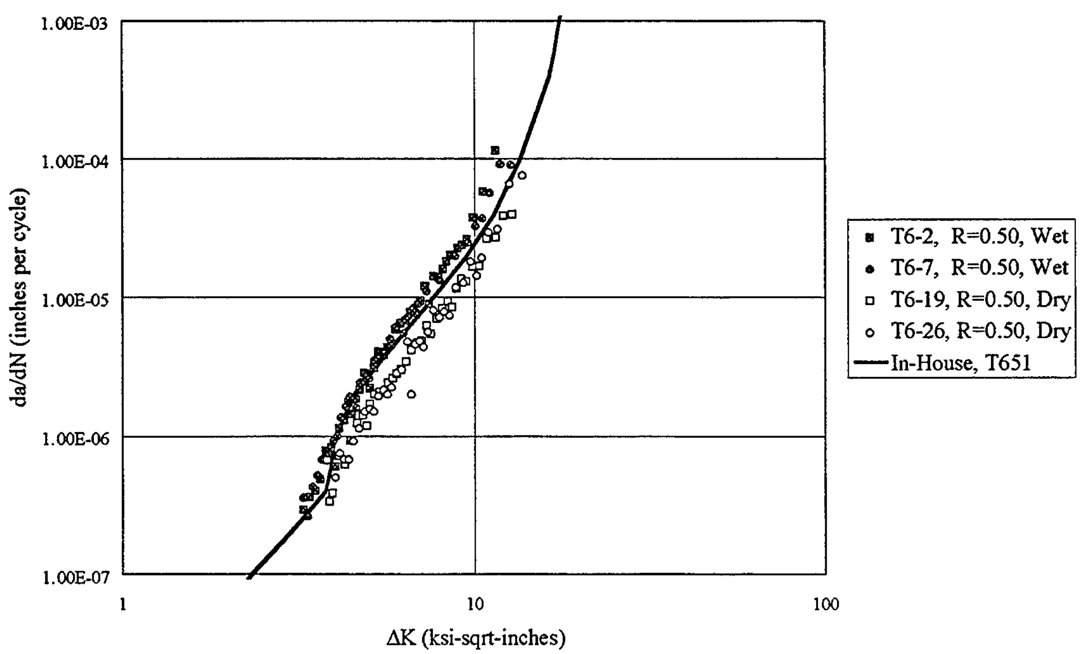

Figure 8 Fatigue Crack Growth Rates for 7075-T6 Al; R= 0.50

If there are no age effects, as was the case suggested for 2024-T3 aluminum, then two other observations might be made from examining Figures 7 and 8. First, at both stress ratios, the "wet" data agreed closely with the ambient data from the Design Handbook and in-house data while the data from the "dry" tests fell lower on the graphs. This may suggest that 7075-T6 Al alloy possesses a humidity level threshold where higher humidity levels would have no further effect on 7075-T6 aluminum's fatigue crack growth rates.

Second, the separation between "wet" and "dry" data is less for the higher stress ratio than the lower. This smaller difference may suggest that the humidity effects are sensitive to the applied stress ratio, where a higher stress ratio diminishes the humidity effects.

6. CONCLUSIONS

This research effort included gathering data on three clad aluminum alloys removed from the fuselage of retired U.S. Air Force C/KC-135 aircraft more than 30 years old. These materials were 2024-T3, 2024-T4, and 7075-T6 Al alloys. The test was designed to further the understanding of the effects of humidity and age on the aluminum alloys' fatigue crack growth rates. The testing performed under this Delivery Order involved identical test specimen configurations subjected to fatigue loading while exposed to two different humidity levels, "wet" (>85%) and "dry" (<15%). Furthermore, these test results were compared to the results of similar tests involving relatively "new" materials to determine if there were any age effects.

Of the three materials, only the 7075-T6 aluminum demonstrated a humidity effect. For the two test conditions of "wet" and "dry" at stress ratios of R=0.50 and R=0.05, 7075-T6 Al displayed an increase of fatigue crack-growth rates in the "wet" environment. These results seem to indicate that the humidity effects were less pronounced in tests conducted at higher stress ratios. Other research examining the effects of corrosion have shown that corrosion effects are diminished by increasing load ratios [4]. Similarly, it would seem that increasing stress ratios may also diminish the effects of humidity.

Additionally, from the results of this effort it seems that fatigue crack-growth rates are similar for relative humidity levels of 60% and 90%, while humidity levels near 5% showed slightly lower crack growth rates. The lack of significant difference in fatigue crack growth rates at the two higher humidity levels suggests that humidity levels above a certain percentage will no longer influence the fatigue crack-growth rate behavior of the 7075-T6 Al alloy. Additional testing, involving a range of humidity levels between 5% and 50-60%, may help to better understand at what levels humidity has no further effect on the fatigue crack-growth rates of 7075-T6 aluminum. Also, further testing would be required to determine the effect of stress ratio on humidity effects. Testing to include stress ratios of 0.7, 0.33, 0.02, and -1.0, which are represented in the Design Handbook, would provide "wet" data to compare against the Design Handbook's baseline data to better understand this phenomenon.

Of the two cases where age effects on fatigue crack-growth rates were examined in this report, 2024-T3 aluminum and 7075-T6 aluminum, only the 2024-T3 aluminum demonstrated no age effect. The results for 7075-T6 aluminum were inconclusive with respect to age, due to lack of data for aged specimens tested at ambient conditions. Therefore, no comparisons could be made with the non-aged data contained in the Design Handbook and in-house data. However, the lack of age effects on fatigue crack-growth rates of several materials has been demonstrated by the research of other organizations [5], which suggests the 7075-T6 aluminum examined in this effort would have behaved similarly. Also, it has been reported, that the effect of age on fatigue crack-growth rates of materials is minimal, while the effects attributed to corrosion appear much more severe [5,6,7].

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8. APPENDICES

8.1. Appendix A - Loads and Conditions

2024-T3			
Specimen #	Smax	Stress Ratio	Humidity
28	15.1	0.50	<15%
35	10.3	0.05	<15%
37	10.3	0.05	<15%
41	15.1	0.50	<15%
33	7.8	0.05	>85%
46	11.5	0.50	>85%
50	11.5	0.50	>85%
51	7.8	0.05	>85%

2024-T4			
Specimen #	Smax	Stress Ratio	Humidity
42	10.9	0.05	<15%
43	12.2	0.50	>85%
47	8.3	0.50	>85%
51	16	0.50	<15%
63	8.3	0.05	>85%
64	10.9	0.05	<15%
65	16	0.50	<15%
73	12.2	0.50	>85%

7075-T6			
Specimen #	Smax	Stress Ratio	Humidity
2	7.3	0.50	>85%
7	7.3	0.50	>85%
18	4.9	0.05	>85%
19	8.5	0.50	<15%
20	5.8	0.05	<15%
26	8.5	0.50	<15%
29	4.9	0.05	>85%
33	5.8	0.05	<15%

8.2. Appendix B - Test Data

TEST REQUIREMENTS									
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity		
As-received	Artificial	15.1	+0.05	+0.50	0.1hz	10hz	<15%	>85%	

C1 ← Machined Notch → C2 ($2a_n$)

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.526 - 3.876

$2a_{n\text{-farside}}$ =

TEST ACTUALS					
	Specimen ID:	2024T3-28			
PRE	Test date:	1 AUG 95		1 AUG 95	
	Lab ID | Machine ID	WL/FIBEC		#14	
	W(inch) | t(inch):	~~1.7501~~ 1.7490		~~.0632~~ 0.06330	
	P_{max}(kip) | P_{min}(kip):	1.679		0.8324	
	Temp(degF) | %RH	71°		6.9%	
		NEAR SIDE		FAR SIDE	
	N	C1	C2	C2	C1
Pre-crack	46,503	3.477	3.939		
1	5,004	3.469	3.949		
2	5,002	3.459	3.958		
3	5,004	3.444	3.971		
4	5,003	3.432	3.985		
5	5,004	3.417	4.002		
6	4,003	3.402	4.015		
7	3,004	3.391	4.025		
8	3,002	3.379	4.037		
9	3,003	3.365	4.051		
10	3,004	3.351	4.066		
11	3,004	3.337	4.081		
12	3,002	3.318	4.100		
13	2504	3.298	4.116		
14	2003	3.281	4.130		
15	1802	3.268	4.141		
16	1703	3.251	4.156		

		NEAR SIDE		FAR SIDE	
	N	C1	C2	C2	C1
17	1,504	3.233	4.174		
18	1,304	3.216	4.187		
19	1304	3.193	4.212		
20	1004	3.180	4.233		
21	804	3.168	4.251		
22	602	3.144	4.268		
23	403	3.137	4.281		
24	404	3.121	4.297		
25	304	3.101	4.318		
26	152	3.084	4.344		
27	35	2.827	4.575		
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TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	10.3	+0.05	+0.50	0.1hz	10hz	<15%	>85%

2a_n

C1 ← Machined Notch → C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.595-3.945

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS			
	Specimen ID:	2024T3-35	
PRE	Test date:	1 Aug 95	1 Aug 95
	Lab ID | Machine ID	WL/FIBEC	#15
	W(inch) | t(inch):	1.7525 ~~1.7538~~	0.06350 ~~0.0634~~
	P_{max}(kip) | P_{min}(kip):	1.1498	0.0582
	Temp(degF) | %RH	71°	6.9%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	35,007	3.548	3.997		
1	5,003	3.536	4.008		
2	5,005	3.525	4.022		
3	5,008	3.511	4.034		
4	5,005	3.496	4.047		
5	5,004	3.478	4.062		
6	4,003	3.461	4.078		
7	3,007	3.447	4.091		
8	3,005	3.432	4.104		
9	3,006	3.416	4.124		
10	2,506	3.400	4.136		
11	2,508	3.388	4.149		
12	2,504	3.375	4.162		
13	2505	3.360	4.182		
14	2004	3.344	4.197		
15	1804	3.330	4.210		
16	1707	3.315	4.228		
17	1503	3.299	4.240		
18	1,304	3.289	4.253		
19	1307	3.276	4.268		
20	1304	3.267	4.282		
21	1304	3.255	4.296		
22	1304	3.241	4.315		
23	1007	3.232	4.328		
24	1006	3.212	4.341		
25	1005	3.203	4.352		
26	1024	3.183	4.379		
27	604	3.169	4.385		
28	604	3.164	4.390		
29	604	3.155	4.397		
30	607	3.148	4.404		
31	907	3.140	4.410		
32	907	3.124	4.426		
33	653	2.894	4.646		
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TEST REQUIREMENTS									
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity		
As-received	Artificial	10.3	+0.05	+0.50	0.1hz	10hz	<15%	>85%	

2a$_n$

C1 ← Machined Notch → C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 4.044 - 3.694

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS

Specimen ID:	2024T3-37	
Test date:	8 Aug 95	8 Aug 95
Lab ID | Machine ID	WL/FIBEC	#15
W(inch) | t(inch):	1.7540 ~~1.7547~~	0.06340 ~~.0632~~
P_{max}(kip) | P_{min}(kip):	1.146	0.056
Temp(degF) | %RH	71°F	7.1%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	34,007	4.091	3.632		
1	5,007	4.100	3.617		
2	5,004	4.113	3.602		
3	5,004	4.126	3.585		
4	4,507	4.132	3.569		
5	4,504	4.148	3.550		
6	4,007	4.162	3.535		
7	4,005	4.176	3.514		
8	3,507	4.193	3.492		
9	3,004	4.207	3.472		
10	2,507	4.218	3.452		
11	2,007	4.228	3.437		
12	2,007	4.244	3.424		
13	1,805	4.255	3.405		
14	1604	4.266	3.386		
15	1,408	4.278	3.371		
16	1,408	4.289	3.354		
17	1,305	4.304	3.336		
18	1240	4.315	3.319		
19	1206	4.332	3.313		
20	1205	4.347	3.310		
21	1208	4.354	3.306		
22	1207	4.366	3.300		
23	1204	4.379	3.290		
24	1206	4.398	3.277		
25	1204	4.413	3.260		
26	1204	4.434	3.229		
27	803	4.455	3.208		
28	466	4.470	3.197		
29	304	4.486	3.176		
30	107	4.494	3.170		
31	107	4.499	3.160		
32	107	4.515	3.136		
33	56	4.529	3.121		
34	36	4.746	~~3.~~ 2.992		
35					
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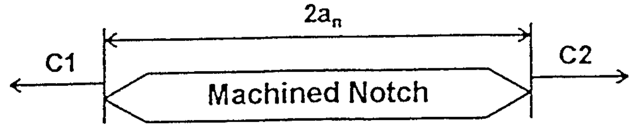
TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	15.1	+0.05	+0.50	0.1hz	10hz	<15%	>85%



View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.913-3.563

$2a_{n\text{-farside}}$ =

TEST ACTUALS		
Specimen ID:	2024T3-41	
Test date:	8 Aug 95	8 Aug 95
Lab ID | Machine ID	WL/FIBEC	#14
W(inch) | t(inch):	1.7510 ~~1.7519~~	0.0645 ~~.0633~~
P_{max}(kip) | P_{min}(kip):	1.706	0.8545
Temp(degF) | %RH	71° F	6.8%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	41,004	3.959	3.509		
1	5,003	3.969	3.499		
2	5,003	3.983	3.485		
3	5,002	3.999	3.471		
4	5,002	4.014	3.455		
5	4,503	4.028	3.438		
6	4,503	4.043	3.421		
7	4,004	4.059	3.412		
8	4,004	4.075	3.392		
9	3,502	4.091	3.373		
10	3,004	4.110	3.357		
11	2,504	4.124	3.338		
12	2,003	4.140	3.324		
13	1,802	4.150	3.306		
14	1,703	4.160	3.290		
15	1,603	4.173	3.276		
16	1,502	4.185	3.258		
17	1,402	4.206	3.241		
18	1,219	4.210	3.227		
19	1203	4.229	3.207		
20	1003	4.240	3.192		
21	1004	4.254	3.171		
22	1004	4.284	3.145		
23	503	4.299	3.129		
24	403	4.322	3.101		
25	119	4.613	2.863		
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TEST REQUIREMENTS									
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity		
As-received	Artificial	10.9	+0.05	+0.50	0.1hz	10hz	<15%	>85%	

2a_n

C1 | Machined Notch | C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.823 - 3.523

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS		
Specimen ID:	2024T4-42	
Test date:	14 Aug 95	14 Aug 95
Lab ID | Machine ID	WL/FIBEC	#14
W(inch) | t(inch):	1.4825 / 1.4838	0.06250
P_{max}(kip) | P_{min}(kip):	1.014	0.046
Temp(degF) | %RH	76°	7.9%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	31,304	3.873	3.474		
1	5,004	3.884	3.461		
2	5,004	3.901	3.446		
3	5,004	3.918	3.432		
4	5,002	3.937	3.412		
5	3,602	3.953	3.397		
6	3,602	3.973	3.382		
7	3,002	3.990	3.368		
8	3,003	4.008	3.354		
9	2504	4.027	3.339		
10	2004	4.038	3.331		
11	2004	4.057	3.320		
12	1,756	4.073	3.305		
13	1,602	4.086	3.294		
14	1,604	4.105	3.278		
15	1203	4.121	3.266		
16	902	4.139	3.254		
17	603	4.148	3.247		
18	602	4.160	3.239		
19	604	4.170	3.229		
20	603	4.185	3.221		
21	603	4.202	3.210		
22	603	4.231	3.194		
23	404	4.261	3.178		
24	175	4.288	3.169		
25	602	4.414	2.932		
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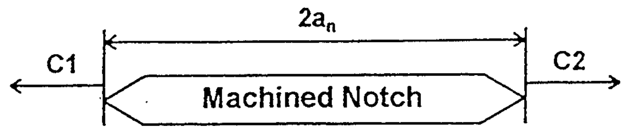
TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	16.0	+0.05	+0.50	0.1hz	10hz	<15%	>85%



View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 4.147 - 3.847

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS		
Specimen ID:	2024T4-S1	
Test date:	14 Aug 95	14 Aug 95
Lab ID | Machine ID	WL/FIBEC	#15
W(inch) | t(inch):	~~1.4833~~ 1.4820	~~[illegible]~~ 0.06650
P_{max}(kip) | P_{min}(kip):	1.481	0.733
Temp(degF) | %RH	76°	8.1%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	37,007	4.199	3.799		
1	5,003	4.212	3.780		
2	5,007	4.229	3.769		
3	5,007	4.250	3.749		
4	4,004	4.269	3.733		
5	3604	4.282	3.714		
6	3,608	4.299	3.696		
7	3,004	4.317	3.671		
8	3,005	4.344	3.648		
9	2,005	4.366	3.631		
10	1,508	4.384	3.616		
11	1,005	4.397	3.603		
12	1,186	4.416	3.584		
13	707	4.428	3.574		
14	3704	4.448	3.557		
15	506	4.457	3.546		
16	406	4.468	3.530		

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
17	305	4.485	3.520		
18	206	4.494	3.494		
19	108	4.507	3.485		
20	59	4.738	3.256		
21					
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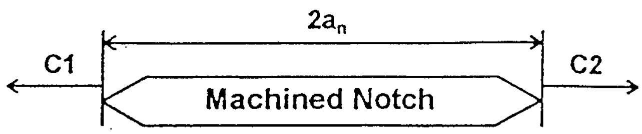
TEST REQUIREMENTS									
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity		
As-received	Artificial	16.0	+0.05	+0.50	0.1hz	10hz	<15%	>85%	



View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 4.095-3.796

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS

Specimen ID:	2024T4-65		
PRE	Test date:	4Aug95	7Aug95
Lab ID | Machine ID		WL/FIBEC	#15
W(inch) | t(inch):		1.48825	0.0628
P_{max}(kip) | P_{min}(kip):		1.4913	0.7382
Temp(degF) | %RH		69°	7.5%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	40,005	4.147	3.742		
1	5,005	4.160	3.729		
2	5,007	4.174	3.718		
3	5,006	4.190	3.700		
4	4,007	4.203	3.686		
5	4,007	4.219	3.670		
6	3505	4.239	3.649		
7	2605	4.253	3.637		
8	2607	4.268	3.623		
9	2604	4.286	3.604		
10	2105	4.303	3.583		
11	2005	4.321	3.572		
12	1908	4.339	3.554		
13	807	4.353	3.537		
14	805	4.365	3.533		
15	805	4.374	3.525		
16	806	4.386	3.510		
17	607	4.402	3.499		
18	504	4.411	3.484		
19	441	4.429	3.467		
20	207	4.437	3.463		
21	207	4.443	3.460		
22	257	4.453	3.447		
23	228	4.475	3.428		
24	71	4.687	3.205		
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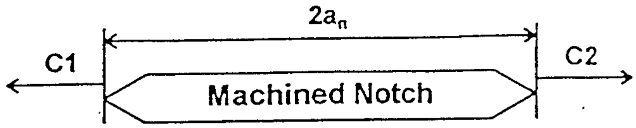
FATIGUE CRACK GROWTH RATE DATA SHEET

TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	10.9	+0.05	+0.50	0.1hz	10hz	<15%	>85%



View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.850 - 3.551

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS		
Specimen ID:	2024T4-64	
PRE | Test date:	4 Aug 95	7 Aug 95
Lab ID | Machine ID	WL/FIBEC	#14
W(inch) | t(inch):	~~14.825~~	.0631 ✓
P_{max}(kip) | P_{min}(kip):	1.036	0.0495
Temp(degF) | %RH	69°	7.3%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	30,002	3.899	3.497		
1	5,002	3.915	3.485		
2	5,004	3.930	3.471		
3	5,003	3.949	3.453		
4	4,003	3.965	3.437		
5	3,503	3.978	3.425		
6	3503	3.991	3.411		
7	3503	4.006	3.397		
8	3502	4.020	3.380		
9	3,002	4.039	3.362		
10	2403	4.052	3.348		
11	2402	4.068	3.331		
12	1903	4.080	3.315		
13	1504	4.092	3.306		
14	1502	4.100	3.296		
15	1503	4.108	3.287		
16	1503	4.127	3.273		
17	1004	4.139	3.262		
18	904	4.151	3.248		
19	719	4.163	3.238		
20	604	4.175	3.230		
21	604	4.184	3.219		
22	602	4.196	3.208		
23	602	4.210	3.193		
24	603	4.224	3.171		
25	403	4.247	3.153		
26	104	4.256	3.142		
27	104	4.264	3.128		
28	102	4.285	3.111		
29	28	4.442	2.960		
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FATIGUE CRACK GROWTH RATE DATA SHEET

TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	8.5	+0.05	+0.50	0.1hz	10hz	<15%	>85%

2an

C1 ← Machined Notch → C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.550 - 3.900

$2a_{n\text{-farside}}$ =

TEST ACTUALS				
Specimen ID:	7075T6-19			
PRE | Test date:	17 JUL 95		18 JUL 95	
Lab ID | Machine ID	WL/FIBEC		#14	
W(inch) | t(inch):	~~1.7535~~ 1.7546		0.0632 ~~.0637~~	
P_{max}(kip) | P_{min}(kip):	0.945		0.476	
Temp(degF) | %RH	76°F		7.2%	

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	190,003	3.496	3.952		
1	15,003	3.488	3.964		
2	15,004	3.482	3.968		
3	30,003	3.473	3.982		
4	30,003	3.451	4.004		
5	25,003	3.433	4.018		
6	20,004	3.415	4.038		
7	15,002	3.396	4.057		
8	10,002	3.380	4.070		
9	8,002	3.371	4.080		
10	8,004	3.357	4.092		
11	8,004	3.345	4.111		
12	7,003	3.331	4.126		
13	6,003	3.319	4.138		
14	6,002	3.304	4.153		
15	5,002	3.291	4.165		
16	5,005	3.277	4.179		
17	5,003	3.262	4.194		
18	5,003	3.245	4.211		
19	4,003	3.229	4.228		
20	3,004	3.216	4.244		
21	3,003	3.200	4.257		
22	2,502	3.185	4.272		
23	2,502	3.173	4.286		
24	2,503	3.156	4.303		
25	2,002	3.139	4.320		
26	1,503	3.122	4.332		
27	1,005	3.114	4.341		
28	1,004	3.100	4.351		
29	1,003	3.090	4.367		
30	1,003	3.076	4.380		
31	1,002	3.061	4.398		
32	752	3.050	4.411		
33	753	3.030	4.430		
34	503	3.017	4.444		
35	403	3.003	4.460		
36	304	2.997	4.479		
37	203	2.849'	4.602		
38					
39					

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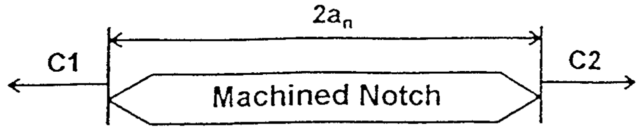
August 30, 1994

FATIGUE CRACK GROWTH RATE DATA SHEET

TEST REQUIREMENTS									
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity		
As-received	Artificial	5.8	+0.05	+0.50	0.1hz	10hz	<15%	>85%	



View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.632 - 3.982

$2a_{n\text{-farside}}$ = ____

TEST ACTUALS		
Specimen ID:	7075T6-20	
PRE | Test date:	17 JUL 95	18 JUL 95
Lab ID | Machine ID	WL/FIBEC	#15
W(inch) | t(inch):	1.7551 ✓	~~.0639~~ 0.06370
P_{max}(kip) | P_{min}(kip):	0.650	0.0305
Temp(degF) | %RH	76°F	6.8%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	190,008	3.578	4.043		
1	25,006	3.571	4.051		
2	30,006	3.562	4.064		
3	30,007	3.548	4.079		
4	20,006	3.538	4.088		
5	20,005	3.530	4.095		
6	20,006	3.521	4.107		
7	14,377	3.512	4.118		
8	15,006	3.503	4.131		
9	15,007	3.491	4.141		
10	15,006	3.480	4.153		
11	15,007	3.465	4.166		
12	15,006	3.448	4.183		
13	13,004	3.432	4.200		
14	12,007	3.417	4.220		
15	10,006	3.402	4.238		
16	9,005	3.385	4.250		

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
17	9,003	3.366	4.274		
18	7,004	3.351	4.296		
19	5,006	3.335	4.313		
20	4,005	3.319	4.325		
21	3,004	3.306	4.338		
22	3,004	3.297	4.350		
23	3,004	3.284	4.366		
24	3,008	3.267	4.382		
25	3,004	3.249	4.400		
26	2,506	3.232	4.420		
27	2,004	3.217	4.436		
28	1,507	3.205	4.448		
29	1507	3.191	4.466		
30	1,004	3.180	4.480		
31	1,005	3.167	4.495		
32	1,004	3.152	4.511		
33	1,004	3.137	4.532		
34	758	3.123	4.548		
35	754	3.105	4.575		
36	408	3.093	4.606		
37	105	3.091	4.634		
38	22	2.929	4.684		
39					

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FATIGUE CRACK GROWTH RATE DATA SHEET

TEST REQUIREMENTS									
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity		
As-received	Artificial	8.5	+0.05	+0.50	0.1hz	10hz	<15%	>85%	

2a_n

C1 ← Machined Notch → C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.572 - 3.922

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS

Specimen ID:	7075T6-26	
PRE — Test date:	25 Jul 95	26 July 95
Lab ID | Machine ID	WL-FIBEC	#14
W(inch) | t(inch):	~~1.7528~~ ~~1.7529~~	~~0.06325~~ ~~.0629~~
P_{max}(kip) | P_{min}(kip):	0.945	0.476
Temp(degF) | %RH	75°F	7.5%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	167,004	3.521	3.972		
1	30,003	3.508	3.981		
2	30,003	3.493	3.999		
3	20,004	3.483	~~3.[illegible]~~	4.009	
4	20,003	3.466	4.022		
5	17,003	3.455	4.034		
6	17,002	3.442	4.045		
7	17,002	3.428	4.063		
8	15,002	3.410	4.080		
9	12,003	3.393	4.099		
10	9,002	3.378	4.112		
11	8,002	3.365	4.123		
12	8,004	3.349	4.138		
13	7,004	3.332	4.152		
14	6,005	3.320	4.164		
15	6,004	3.305	4.176		
16	6,004	3.287	4.193		
17	5,003	3.274	4.210		
18	4,004	3.260	4.224		
19	3,503	3.249	4.237		
20	3504	3.233	4.253		
21	2504	3.220	4.264		
22	2,520	3.209	4.275		
23	2,504	3.195	4.289		
24	2,504	3.175	4.309		
25	1903	3.161	4.322		
26	1904	3.146	4.338		
27	1704	3.133	4.350		
28	1704	3.113	4.371		
29	1303	3.097	4.388		
30	1002	3.077	4.405		
31	702	3.069	4.417		
32	602	3.059	4.430		
33	~~602~~	~~3.044~~	~~[illegible]~~	~~4.449~~	
34	602	3.044	4.449		
35	503	3.029	4.464		
36	404	3.008	4.497		
37	152	2.993	4.506		
38	90	2.871	4.623		
39					

FATIGUE CRACK GROWTH RATE DATA SHEET

Boeing-PSD

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Corrsion State		Smax	R-ratio		Cy Frequency		Relative Humidity	
As-received	Artificial	5.8	+0.05	+0.50	0.1hz	10hz	<15%	>85%

$2a_n$

C1 ← Machined Notch → C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.622 - 3.972

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS

Specimen ID:	7075T6-33	
PRE | Test date:	25 Jul 95	26 Jul 95
Lab ID | Machine ID	WL-FIBEC	#15
W(inch) | t(inch):	1.7532 ✓	0.06320 ~~.06628~~
P_{max}(kip) | P_{min}(kip):	0.650	0.0315
Temp(degF) | %RH	75°F	7%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	160,007	3.576	4.025		
1	30,008	3.565	4.035		
2	30,007	3.551	4.049		
3	25,005	3.541	4.062		
4	25,006	3.529	4.071		
5	25,005	3.504	4.077		
6	20,004	3.494	4.093		
7	20,004	3.479	4.106		
8	17,006	3.476	4.114		
9	17,005	3.459	4.127		
10	17,007	3.437	4.148		
11	13,008	3.420	4.165		
12	11,007	3.405	4.182		
13	9,008	3.391	4.198		
14	8,006	3.376	4.214		
15	6,005	3.362	4.227		
16	6,006	3.348	4.245		

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
17	5,004	3.334	4.256		
18	5,006	3.317	4.273		
19	4,006	3.305	4.289		
20	3,506	3.291	4.300		
21	3505	3.275	4.317		
22	3,024	3.260	4.332		
23	2,505	3.246	4.344		
24	2,506	3.233	4.358		
25	2508	3.214	4.377		
26	1908	3.198	4.392		
27	1704	3.184	4.410		
28	1705	3.164	4.427		
29	1307	3.145	4.445		
30	1004	3.131	4.458		
31	708	3.120	4.470		
32	607	3.111	4.481		
33	603	3.097	4.495		
34	507	3.085	4.507		
35	505	3.067	4.522		
36	408	3.049	4.538		
37	207	3.045	4.548		
38	204	3.037	4.562		
39	204	3.027	4.587		4.5[illegible]

36	3.024	~~4.954~~
36	3.018	4.602
36	2.920	4.673

FATIGUE CRACK GROWTH RATE DATA SHEET

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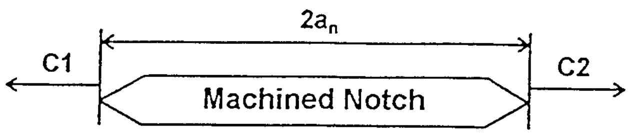
TEST REQUIREMENTS

Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	7.8	+0.05	+0.50	0.1hz	10hz	<15%	>85%



View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.955 - 3.605

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS

Specimen ID:	2024T3-33		
Test date:	26 Jun 95	27 Jun 95	
Lab ID | Machine ID	WL/FIBEC	#14	
W(inch) | t(inch):	~~1.7550~~ 1.7545	.0633 ✓	
P_{max}(kip) | P_{min}(kip):	0.868	0.041	
Temp(degF) | %RH	75°	88%	

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	128,003	3.993	3.542		
1	15,002	4.007	3.529		
2	15,003	4.029	3.516		
3	12,003	4.043	3.501		
4	10,003	4.061	3.487		
5	9,002	4.080	3.472		
6	8,003	4.099	3.457		
7	7,002	4.119	3.444		
8	6,003	4.134	3.429		
9	5,504	4.154	3.411		
10	4,502	4.172	3.395		
11	4,004	4.184	3.381		
12	4,004	4.201	3.361		
13	3,004	4.216	3.350		
14	3,003	4.227	3.329		
15	3,004	4.246	3.318		
16	3,003	4.258	3.303		
17	3,004	4.279	3.285		
18	2,003	4.291	3.274		
19	2,002	4.307	3.261		
20	1,503	4.319	3.250		
21	1,502	4.332	3.238		
22	1502	4.346	3.226		
23	1503	4.363	3.210		
24	1,003	4.381	3.193		
25	1,005	4.397	3.183		
26	1,004	4.415	3.169		
27	1,002	4.430	3.151		
28	805	4.445	3.138		
29	603	4.462	3.125		
30	404	4.478	3.110		
31	203	4.483	3.100		
32	202	4.487	3.098		
33	203	4.497	3.093		
34	203	4.507	3.084		
35	203	4.527	3.070		
36	55	4.536	3.069		
37	47	4.545	3.062		
38	50	4.661	2.907		
39					

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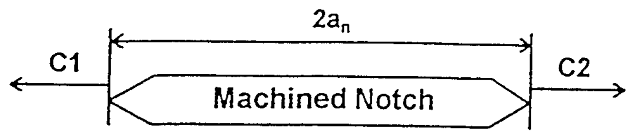
FATIGUE CRACK GROWTH RATE DATA SHEET

TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	11.5	+0.05	+0.50	0.1hz	10hz	<15%	>85%



View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.957 - 3.607

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS		
Specimen ID:	2024T3-46	
PRE | Test date:	26 Jun 95	27 Jun 95
Lab ID | Machine ID	WL / FIBEC	#15
W(inch) | t(inch):	1.7504 ✓	.0634 ✓
P_{max}(kip) | P_{min}(kip):	1.277	0.637
Temp(degF) | %RH	76°	88%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	117,004	4.008	3.559		
1	10,007	4.016	3.548		
2	15,005	4.037	3.522		
3	9,008	4.049	3.507		
4	8,007	4.064	3.491		
5	7,005	4.076	3.480		
6	7,007	4.090	3.465		
7	6,504	4.104	3.448		
8	6,005	4.119	3.433		
9	5,505	4.134	3.417		
10	5,008	4.147	3.398		
11	4,507	4.163	3.383		
12	4,005	4.182	3.369		
13	3,007	4.193	3.357		
14	3,008	4.204	3.343		
15	3,008	4.220	3.326		
16	3,007	4.235	3.312		

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
17	3,007	4.251	3.290		
18	2,505	4.274	3.274		
19	2,004	4.286	3.256		
20	1,506	4.298	3.245		
21	1,504	4.311	3.232		
22	1505	4.326	3.213		
23	1,003	4.336	3.202		
24	1,005	4.347	3.193		
25	1,007	4.360	3.182		
26	1,004	4.374	3.165		
27	1,004	4.390	3.146		
28	8,07	4.403	3.127		
29	606	4.422	3.112		
30	406	4.432	3.092		
31	203	4.448	3.081		
32	104	4.460	3.065		
33	40	4.654	2.904		
34					
35					
36					
37					
38					
39					

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FATIGUE CRACK GROWTH RATE DATA SHEET

TEST REQUIREMENTS									
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity		
As-received	Artificial	11.5	+0.05	+0.50	0.1hz	10hz	<15%	>85%	

2a$_n$

C1 ← Machined Notch → C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.939 - 3.589

$2a_{n\text{-farside}}$ =

TEST ACTUALS

Specimen ID:	2024T3-50	
PRE / Test date:	30 JUN 95	
Lab ID | Machine ID	WL | FIBEC	#15
W(inch) | t(inch):	1.7588 ~~1.7584~~	0.0636 ~~0.0635~~
P_{max}(kip) | P_{min}(kip):	1.2848	0.6344
Temp(degF) | %RH	79°	88%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	127,006	3.999	3.537		
1	~~15,002~~	~~3.99[illegible]~~	~~3.5[illegible]~~		
2	15,006	4.019	3.511		
3	10,004	4.038	3.501		
4	8,007	4.047	3.488		
5	8,003	4.061	3.473		
6	7,004	4.070	3.462		
7	7,005	4.083	3.453		
8	7,006	4.100	3.434		
9	6,005	4.115	3.419		
10	5,005	4.132	3.400		
11	4,007	4.144	3.390		
12	4,003	4.155	3.377		
13	4,005	4.172	3.362		
14	4,003	4.188	3.350		
15	4,004	4.205	3.332		
16	3,007	4.222	3.321		
17	3007	4.238	3.308		
18	2004	4.252	3.290		
19	2004	4.267	3.276		
20	2004	4.282	3.262		
21	2004	4.299	3.249		
22	2008	4.311	3.229		
23	2004	4.330	3.208		
24	1504	4.350	3.191		
25	1504	4.370	3.173		
26	1006	4.389	3.155		
27	805	4.404	3.138		
28					
29	1005	4.422	3.124		
30	403	4.432	3.113		
31	307	4.441	3.097		
32	155	4.451	3.090		
33	106	4.462	3.078		
34	35	4.639	2.889		
35					
36					
37					
38					
39					

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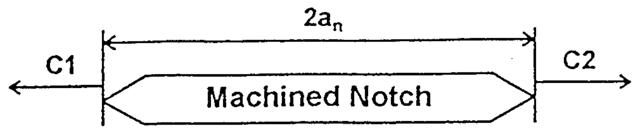
FATIGUE CRACK GROWTH RATE DATA SHEET

(○)

TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	7.8	+0.05	+0.50	0.1hz	10hz	<15%	>85%



View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.896-3.547

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS		
Specimen ID:	2024T3-S1	
PRE | Test date:	30 JUN 95	
Lab ID | Machine ID	WL/FIBEC	#14
W(inch) | t(inch):	1.75260 ✓	0.0636
P_{max}(kip) | P_{min}(kip):	0.8795	0.0354
Temp(degF) | %RH	79°	88%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	135,002	3.985	3.489		
1	~~15,005~~	3.943	3.478		
2	15,002	[illegible]	[illegible]		
3	15,002	3.458	3.960		
4	5,004	3.449	3.968		
5	5,002	3.441	3.975		
6	7,003	3.430	3.985		
7	7,002	3.416	3.998		
8	7,004	3.400	4.012		
9	6,003	3.387	4.026		
10	5,005	3.374	4.038		
11	5,003	3.362	4.056		
12	5,005	3.343	4.071		
13	4,003	3.330	4.082		
14	4,004	3.316	4.093		
15	4,002	3.300	4.107		
16	4,002	3.283	4.123		
17	3003	3.265	4.138		
18	2002	3.255	4.145		
19	2004	3.249	4.152		
20	2502	3.238	4.164		
21	2504	3.224	4.179		
22	2505	3.206	4.192		
23	2502	3.187	4.210		
24	2002	3.169	4.220		
25	2003	3.151	4.234		
26	2004	3.132	4.250		
27	1002	3.124	4.257		
28	~~1003~~ 2006	3.095	4.279		
29	1003	3.079	4.289		
30	1003	3.066	4.302		
31	1004	3.046	4.316		
32	703	3.032	4.328		
33	702	3.010	4.342		
34	603	2.985	4.356		
35	403	2.942	4.377		
36	53	2.919	4.386		
37	17	2.846	4.598		
38					
39					

TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	12.2	+0.05	+0.50	0.1hz	10hz	<15%	>85%

C1 ← 2a_n → C2

Machined Notch

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 4.045 - 3.746

$2a_{n\text{-farside}}$ =

TEST ACTUALS

Specimen ID:	202474-43
PRE | Test date:	15 June 95 | 19 Jun 95
Lab ID | Machine ID	WL/FIBEC | #14
W(inch) | t(inch):	1.4835 | 0.9625
P_{max}(kip) | P_{min}(kip):	1.129 | 0.565
Temp(degF) | %RH	77°F | 89 %

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	109,004	4.103	3.697		
1	10,004	4.111	3.686		
2	15,004	4.138	3.657		
3	8,003	4.154	3.640		
4	6,003	4.165	3.622		
5	5,004	4.177	3.603		
6	4,005	4.190	3.590		
7	4,003	4.199	3.580		
8	4,003	4.216	3.568		
9	4,003	4.228	3.552		
10	3,503	4.240	3.540		
11	3,504	4.255	3.521		
12	2,504	4.268	3.512		
13	2,504	4.278	3.498		
14	2,503	4.290	3.485		
15	2,503	4.313	3.469		
16	1,504	4.320	3.460		
17	1504	4.330	3.451		
18	~~1502~~	~~4.343~~	~~[illegible]~~		
19	1502	4.343	3.436		
20	1503	4.357	3.421		
21	1503	4.377	3.402		
22	1253	4.403	3.380		
23	1254	4.424	3.352		
24	1003	4.480	3.309		
25	555	4.632	3.149		
26					
27					
28					
29					
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31					
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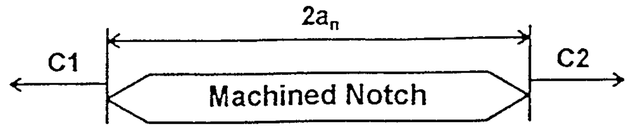
36					
37					
38					
39					

TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	8.3	+0.05	+0.50	0.1hz	10hz	<15%	>85%



View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 4.107 3807

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS		
Specimen ID:	2024T4-47	
PRE / Test date:	15 JUN 95	19 JUN 95
Lab ID / Machine ID	WL/FIBEC	#15
W(inch) / t(inch):	1.4830	0.0623
P_{max}(kip) / P_{min}(kip):	0.766	0.037
Temp(degF) / %RH	76°F	89%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	100003	4.177	3.748		
1	10,004	4.192	3.731		
2	10,004	4.213	3.714		
3	8,009	4.236	3.698		
4	6,005	4.251	3.678		
5	4,007	4.272	3.667		
6	3,005	4.279	3.655		
7	3,003	4.293	3.646		
8	3,005	4.309	3.634		
9	3,005	4.325	3.617		
10	2,508	4.344	3.603		
11	2,005	4.361	3.591		
12	1,504	4.365	3.582		
13	1,504	4.375	3.574		
14	1,504	4.385	3.562		
15	1,503	4.402	3.552		
16	1,005	4.411	3.545		
17	1006	4.420	3.531		
18	1004	4.429	3.530		
19	1007	4.454	3.520		
20	1006	4.462	3.510		
21	1007	4.474	3.499		
22	1006	4.490	3.485		
23	1006	4.516	3.469		
24	803	4.540	3.454		
25	604	4.574	3.437		
26	208	4.698	3.215		
27					
28					
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Boeing-PSD
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FATIGUE CRACK GROWTH RATE DATA SHEET

TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	8.3	+0.05	+0.50	0.1hz	10hz	<15%	>85%

2a_n

C1 ← Machined Notch → C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 4.105 - 3.806

$2a_{n\text{-farside}}$ = ____

TEST ACTUALS

	Specimen ID:	2024T4-63	
PRE	Test date:	21 JUN 95	22 JUN 95
	Lab ID | Machine ID	WL|FIBEC	#15
	W(inch) | t(inch):	1.11830	0.0631
	P_{max}(kip) | P_{min}(kip):	0.779	0.036
	Temp(degF) | %RH	76	87.5

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	96,007	4.163	3.753		
1	10,003	4.175	3.741		
2	10,008	4.191	3.723		
3	9,005	4.204	3.705		
4	8,005	4.221	3.690		
5	7,003	4.240	3.674		
6	6,006	4.255	3.656		
7	5,006	4.270	3.641		
8	4,504	4.282	3.626		
9	4,505	4.300	3.613		
10	4,504	4.318	3.595		
11	4,004	4.333	3.576		
12	3,506	4.356	3.556		
13	2,506	4.368	3.539		
14	2,006	4.380	3.531		
15	2,006	4.395	3.522		
16	2,007	4.412	3.501		
17	1,006	4.420	3.491		
18	1,007	4.429	3.483		
19	1,208	4.441	3.472		
20	1,203	4.456	3.460		
21	1,205	4.470	3.444		
22	1,206	4.484	3.427		
23	1208	4.508	3.405		
24	1007	4.533	3.381		
25	505	4.555	3.360		
26	154	4.565	3.350		
27	155	4.582	3.338		
28	56	4.590	3.330		
29	39	4.697	3.214		
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FATIGUE CRACK GROWTH RATE DATA SHEET

Boeing-PSD

TEST REQUIREMENTS									
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity		
As-received	Artificial	12.2	+0.05	+0.50	0.1hz	10hz	<15%	>85%	

2a_n

C1 ← Machined Notch → C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 3.961 – 3.662

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS		
Specimen ID:	2024T4-73	
ARE | Test date:	21 JUN 95	22 JUN. 95
Lab ID | Machine ID	WL|FIBEC	#14
W(inch) | t(inch):	1.4834	0.0620 ~~0.0619~~
P_{max}(kip) | P_{min}(kip):	1.124	0.560
Temp(degF) | %RH	75	88.5

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	116,003	4.006	3.610		
1	10,003	4.020	3.598		
2	10,004	4.031	3.587		
3	10,003	4.048	3.571		
4	9,002	4.062	3.553		
5	8,002	4.081	3.538		
6	7,003	4.096	3.522		
7	6,003	4.115	3.507		
8	5,004	4.130	3.493		
9	4,503	4.147	3.480		
10	4,504	4.165	3.462		
11	4,004	4.183	3.445		
12	3,504	4.195	3.430		
13	3,003	4.211	3.409		
14	2,002	4.224	3.401		
15	2,003	4.231	3.390		
16	2,003	4.246	3.377		
17	1,504	4.257	3.366		
18	1,503	4.270	3.352		
19	1,504	4.282	3.340		
20	1502	4.298	3.326		
21	1504	4.314	3.310		
22	1203	4.330	3.292		
23	1002	4.346	3.277		
24	802	4.360	3.261		
25	603	4.386	3.231		
26	289	4.554	3.070		
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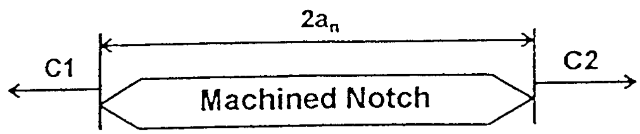
FATIGUE CRACK GROWTH RATE DATA SHEET

Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	7.3	+0.05	+0.50	0.1hz	10hz	<15%	>85%



View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 4.101 - 3.660

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS		
Specimen ID:	707576-2	
Test date:	31 MAY 95	
Lab ID | Machine ID	WL/FIBEC	#14
W(inch) | t(inch):	1.7540 ~~1.7548~~	0.06340 ~~.0650~~
P_{max}(kip) | P_{min}(kip):	0.816	0.411
Temp(degF) | %RH	75°	91%

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	430,002	4.079	3.630		
1	50,004	4.092	3.615		
2	50,004	4.112	3.600		
3	35,004	4.127	3.587		
4	30,003	4.141	3.572		
5	25,003	4.159	3.552		
6	20,005	4.174	3.535		
7	15,004	4.181	3.525		
8	15,003	4.201	3.511		
9	10,003	4.212	3.496		
10	8,003	4.226	3.482		
11	7,005	4.237	3.473		
12	7,003	4.250	3.460		
13	7,003	4.265	3.445		
14	6,005	4.281	3.427		
15	5,005	4.294	3.418		
16	5,003	4.308	3.401		
17	4,003	4.327	3.387		
18	3,003	4.338	3.375		
19	3,003	4.351	3.363		
20	2,504	4.363	3.352		
21	2,504	4.377	3.338		
22	2,503	4.393	3.323		
23	2,003	4.407	3.310		
24	2,003	4.425	3.296		
25	1,503	4.438	3.285		
26	1,502	4.452	3.270		
27	1,003	4.463	3.257		
28	1,007	4.475	3.251		
29	1,001	4.489	3.237		
30	800	4.501	3.227		
31	602	4.511	3.218		
32	500	4.521	3.209		
33	400	4.530	3.202		
34	401	4.539	3.195		
35	400	4.549	3.187		
36	400	4.562	3.181		
37	401	4.577	3.176		
38	401	4.595	3.163		
39	302	4.619	3.152		
40	202	4.657	3.143		
41	9	4.716	2.962		

FATIGUE CRACK GROWTH RATE DATA SHEET

Boeing-PSD

August 30, 1994

TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	7.3	+0.05	+0.50	0.1hz	10hz	<15%	>85%

2a_n

C1 ← Machined Notch → C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 4.169 - 3.759

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS				
Specimen ID:	7075T6-7			
Test date:	25 MAY 95			
Lab ID | Machine ID	WPAFB		#15	
W(inch) | t(inch):	~~1.7548~~ 1.7540 1.7540		0.0635 ~~.0650~~	
P_{max}(kip) | P_{min}(kip):	0.812		0.4065	
Temp(degF) | %RH	76°F		91.3%	

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	298,003	4.164	3.714		
1	35,007	4.173	3.698		
2	40,005	4.183	3.688		
3	35,006	4.198	3.672		
4	27,004	4.211	3.657		
5	20,004	4.228	3.647		
6	13,006	4.236	3.635		
7	15,008	4.248	3.626		
8	15,004	4.261	3.611		
9	11,004	4.272	3.600		
10	11,006	4.290	3.588		
11	8,004	4.300	3.572		
12	6,006	4.311	3.560		
13	6,004	4.322	3.550		
14	6,004	4.333	3.542		
15	6,006	4.349	3.528		
16	6,506	4.367	3.515		
17	5,007	4.377	3.499		
18	5,005	4.396	3.483		
19	4,003	4.411	3.469		
20	4,004	4.426	3.452		
21	4,008	4.445	3.431		
22	2,003	4.459	3.421		
23	2,004	4.471	3.407		
24	2,004	4.483	3.397		
25	2,005	4.497	3.382		
26	1,507	4.512	3.371		
27	1507	4.525	3.356		
28	3005	4.563	3.327		
29	2507	4.592	3.290		
30	2005	4.631	3.250		
31	508	4.646	3.239		
32	508	4.664	3.225		
33	257	4.673	3.214		
34	257	4.685	3.198		
35	204	4.702	3.179		
36	105	4.713	3.170		
37	54	4.812	3.059		
38					
39					

FATIGUE CRACK GROWTH RATE DATA SHEET

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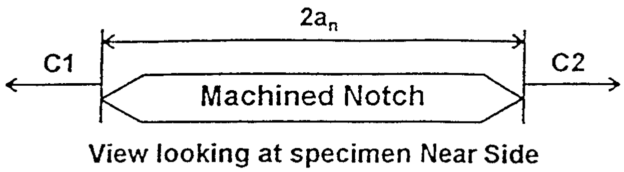
TEST REQUIREMENTS								
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	4.9	+0.05	+0.50	0.1hz	10hz	<15%	>85%



$2a_{n\text{-nearside}}$ = ~~4.168 3.717~~ 4.115 3.765

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS		
Specimen ID:	707576-18	
PRE | Test date:	8 Jun 95, 9 Jun 95	
Lab ID | Machine ID	WL/FIBEC	#15
W(inch) | t(inch):	~~1.7543~~ 1.7530	0.06350 ~~.0630~~
P_{max}(kip) | P_{min}(kip):	0.545	0.027
Temp(degF) | %RH	76°F	88

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1		N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	273006	4.168	3.717			23	2008	4.543	3.363		
1	36,007	4.175	3.707			24	1508	4.557	3.348		
2	40,006	4.184	3.695			25	1004	4.574	3.338		
3	50,004	4.198	3.680			26	753	4.586	3.323		
4	50,027	4.217	3.665			27	507	4.595	3.316		
5	40,007	4.231	3.655			28	510	4.602	3.310		
6	40,006	4.242	3.638			29	507	4.610	3.303		
7	40,007	4.258	3.626			30	507	4.620	3.296		
8	40,042	4.279	3.605			31	507	4.634	3.285		
9	30,036	4.297	3.587			32	507	4.651	3.274		
10	25,007	4.312	3.568			33	507	4.668	3.263		
11	20,014	4.341	3.541			34	512	4.684	3.247		
12	10,008	4.364	3.522			35	408	4.696	3.235		
13	5,008	4.376	3.510			36	411	4.717	3.217		
14	5,008	4.390	3.498			37	304	4.737	3.201		
15	5,004	4.407	3.482			38	205	4.773	3.187		
16	4,006	4.425	3.467			39	23	4.817	3.064		

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
17	3010	4.438	3.456		
18	3006	4.453	3.441		
19	2504	4.470	3.429		
20	2516	4.485	3.414		
21	2511	4.504	3.397		
22	2007	4.521	3.381		

Boeing-PSD
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FATIGUE CRACK GROWTH RATE DATA SHEET

TEST REQUIREMENTS							
Corrsion State		Smax	R-ratio		Cyclic Frequency		Relative Humidity	
As-received	Artificial	4.9	+0.05	+0.50	0.1hz	10hz	<15%	>85%

2a_n

C1 ← Machined Notch → C2

View looking at specimen Near Side

$2a_{n\text{-nearside}}$ = 4.012 − 3.662

$2a_{n\text{-farside}}$ = ______

TEST ACTUALS				
Specimen ID:	7075T6-29			
PRE | Test date:	9 JUNE 95	12 JUNE 95		
Lab ID | Machine ID	WL/FIBEC	#14		
W(inch) | t(inch):	1.7510 ~~1.7519~~	0.0633 ~~.0629~~		
P_{max}(kip) | P_{min}(kip):	0.550	0.030		
Temp(degF) | %RH	74°F	88		

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
Pre-crack	270,004	4.063	3.610		
1	40,005	4.085	3.585		
2	30,003	4.090	3.568		
3	30,007	4.106	3.552		
4	25,003	4.111	3.543		
5	25,003	4.116	3.533		
6	25,003	4.127	3.517		
7	25,004	4.135	3.505		
8	25,004	4.148	3.495		
9	25,004	4.160	3.483		
10	25,004	4.173	3.465		
11	25,007	4.187	3.439		
12	25,008	4.217	3.413		
13	15 004	4.240	3.377		
14	10,004	4.265	3.341		
15	7,504	4.288	3.307		
16	5,003	4.313	3.278		

	N	NEAR SIDE C1	NEAR SIDE C2	FAR SIDE C2	FAR SIDE C1
17	2505	4.325	3.261		
18	2502	4.342	3.241		
19	2004	4.355	3.223		
20	2004	4.370	3.199		
21	1504	4.387	3.178		
22	1003	4.398	3.162		
23	1004	4.411	3.139		
24	1003	4.425	3.117		
25	752	4.435	3.092		
26	753	4.450	3.067		
27	503	4.461	3.040		
28		~~[illegible]~~	~~[illegible]~~		
29	303	4.466	3.018		
30	53	4.471	3.009		
31	53	4.485	2.961		
32	29	4.493			
33	22	4.502			
34	22	4.510			
35	43	4.525			
36	43	4.535			
37	43	4.554			
38	39	4.712			
39					

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August 30, 1994

FATIGUE CRACK GROWTH RATE DATA SHEET